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Supplemental Notice.

No. 9.

*On the Great Comet of 1861.** By the Rev. T. W. Webb.

Though the observations which I was able to obtain of the physical aspect of the late splendid Comet are in several respects far from complete, I am induced to beg permission to submit them to the notice of the Astronomical Society, by the conviction that, in the case of objects so ill-defined and little understood, the accumulation and comparison of evidence will be likely to lead to a more satisfactory result upon the whole than might be attained, even under the most favourable circumstances, by any one observer, unaided and unchecked by independent testimony.

The observations which follow will be rendered more conveniently intelligible, if, instead of being retained in the form of a diary, they are arranged under separate heads, corresponding with the general structure of the comet.

The same telescope was employed throughout, having an excellent object-glass by Alvan Clark, of $5\frac{1}{2}$ -inches aperture and 7 feet focal length.

I. *The Nucleus.*—On the evening of June 30, when, in common with the great majority of observers, I caught the first surprising view of this grand comet, the nucleus, a mere point in the comet eye-piece, and gradually opening and softening with increase of magnifying power, was expanded with about 460 into a fine luminous disc, estimated by a very rough guess at about $2''\dagger$ in diameter, having an uniformly distributed golden light, intermediate probably between that of *Venus* and *Jupiter*; and a very ill-terminated, but still definite, limb, which would, no doubt, have been much more distinctly marked at a higher altitude. It was quite circular, and showed no tendency whatever to a phasis.

* Comet II. 1861.

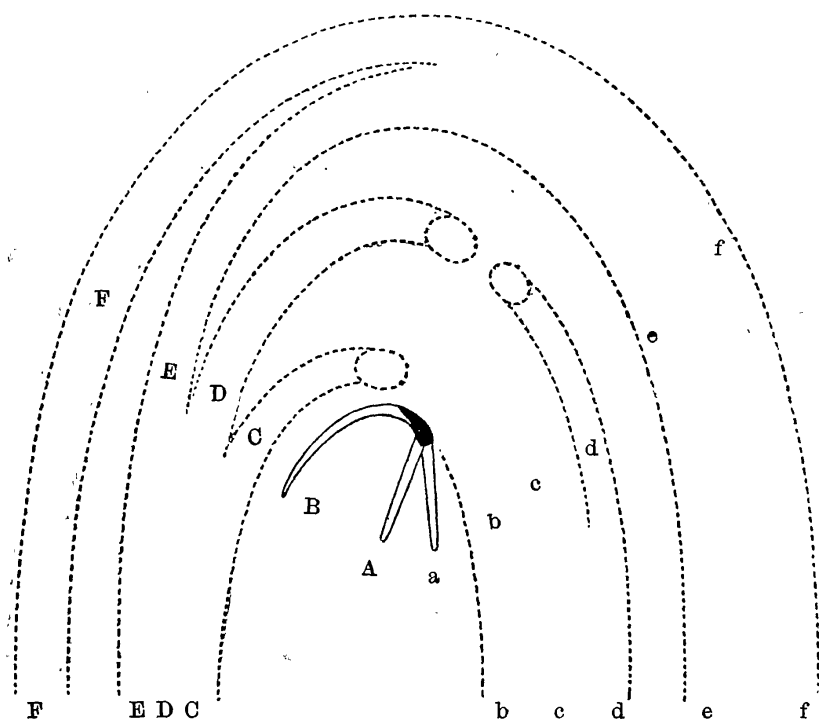
† This, I have since thought, was underrated.—T. W. W.

July 1 having been cloudy, on July 2 the nucleus was found to be equally brilliant, but already much smaller, and less abruptly distinguished from the adjacent luminosity, though the sky was not unfavourable.

July 3, in earlier twilight and a more vaporous atmosphere, the nucleus is entered as "small, dull, and ill-defined," with 460, though still a sharp and vivid point with 110.

July 4, the nucleus was estimated as not exceeding $0''.5$, but this was probably in defect; and it subsequently proceeded in a course of degradation, till, on July 15, it was "extremely dim and nebulous" with 460, and even with low powers, though still vivid, was evidently losing its sharpness.

II. *The Envelopes.* — The number and complex arrangement of these luminous veils on June 30, as seen in the comet eye-piece, with a field of about $52'$, and a power of 27, produced a singular as well as magnificent effect: it was as though a number of light, hazy clouds were floating around a miniature full moon. Portions of six could be more or less distinctly traced, as in fig. 1. The innermost of these (Aa in the key) was very narrow and short, faint on the left hand,



but brighter on the right in the inverted view, and coming up close to the nucleus. The second was a parabolic arc (Bb), in which the nucleus stood, but at some little distance from the vertex. The portion of it extending from the nucleus towards the inverted left, or orbitally following side, exhibited the most

vivid light of any of the envelopes, especially towards the nucleus, from which it seemed to issue straight out as an actual jet or stream, strongly luminous even with a power of 460. Its opposite branch beyond the nucleus was so much more faint and confused, that at the time its character was mistaken; it was not recognised as the prolongation of the same arc, which was erroneously, as I believe, referred to the right side (a) of the innermost envelope; nor was the mistake perceived till the next observation made the true structure of the head apparent, according to the best judgment which I could then form. It may here be remarked that these two interior veils were both in apparent contact with the nucleus, from which all the outer ones were clearly separated. The third envelope (cc) was only traceable on the left side, the opposite branch being merged in a diffuse haze. A little to the left of the probable direction of the radius vector it was kindled up into a small, bright, ill-defined cloud, more luminous than the rest of the curve, but not attaining the condensed light of the parabola next within it. The darkest portion of all the vacancies in the head was the space comprised between the left side of this envelope and the corresponding branch of the bright parabola within it, towards the visible termination of the latter. The 4th envelope (dd) took a considerably wider sweep: on the left hand it was confounded with the previous one, but arose out of it towards its vertex, leaving an interval of fainter light: on the right hand, according to the sketch taken at the time, the envelopes 2, 3, and 4, were all merged in one continuous veil, the outer and inner boundaries of which were alone distinguishable. Somewhere near the direction of the radius vector, as conjectured from the position of the innermost envelope, there was an indentation in the parabolic outline of dd, on each side of which there was a patch of more condensed light — that on the right was not very conspicuous, but the one to the left was much more luminous, exceeding in size and brightness the patch in the envelope cc, and forming a striking feature in the head: a line through this patch, and that in cc, passed far to the left of the nucleus. The 5th envelope (ee) was a faint, narrow stream, undistinguishable from dd to the left, but separated widely towards the right by the comparatively dark space which caused the indentation already mentioned in dd. Ff, the 6th, a similar narrow faint stream, had a distinct existence to the left, beyond a vacant interval, but was blended with the 5th towards the vertex of the parabola. Outside of these lay a great extent of scattered nebulous light on every side, fading gradually into the clear sky. None of the six envelopes could be traced for any distance backwards, all of them becoming speedily lost in the diffused train.

Fig. 5 represents the nucleus and brilliant jet, as seen with a power of 460; sketched, however, merely from memory.

On the next night of observation, July 2, the envelopes were found to be considerably changed, as in fig. 2, and still more confused on the right or orbitally preceding side of the head. Each branch of the first or innermost envelope was now equally faint: the great curve of No. 2 had become distinctly thicker, its prolongation beyond the nucleus continuing very dim: 3 and 4 were blended into one broad veil, all the luminous patches in them had faded, and the included area had become filled with nebulous light, stronger than the remoter parts of the head; the indentation in the outer boundary of No. 4 could be still traced, and the definite outline of the vertex of this envelope, contrasted with an exterior area of comparative darkness, was one of the most remarkable features of the head. This dark space was soon lost towards the right in confused nebulosity; its left end was at first supposed to be continuous with the broad vacancy exterior to the parabolic arc No. 2; but it was subsequently thought to be cut off from it by a feeble remnant of Nos. 3 and 4. Envelopes 5 and 6 were now combined into one broad veil, which passed away into the train.

July 3. I have no note of the aspect of the envelopes, having my attention drawn to other points, in a sky full of strong twilight and haze.

July 4. There is a comparatively dark and tolerably defined space in the head, as in fig. 3, exterior to the sector now formed, about one-third of its breadth, encompassing it as far as it is distinctly marked, and prolonged a little beyond it on the lower inverted side. Outside of this vacancy all is diffuse nebulosity, with some doubtful traces of streakiness, as if envelopes still existed there, not separately distinguishable. The orbitally preceding or south side is especially confused and ill made out.

July 5. The dark area is nearly obliterated, but the coma exterior to it seems streaky, as though composed of a number of narrow veils.

July 8. No envelopes remain.

III. *The Luminous Sector or Fan.*—This, as immediately connected with the nucleus, might have been described before; but, as its formation was at first incomplete, the observations may be more intelligible from its postponement. The first indication of its existence was the very intense light of that portion of the parabolic arc, or second envelope, which seemed to issue from the left side of the nucleus. This was very conspicuous in the first observation, and probably continued traceable, with little alteration, to the last. It has been drawn in fig. 1, as represented in the original sketch, coinciding with the external edge of the parabola; but I could not be confident as to this, not having expressly attended to the point; and from subsequent appearances it is more likely that it followed the interior curve of that envelope. It had not been noticed

in sketching with the low power of the comet eyepiece, about 27, but was clearly brought out with powers of about 110, 170, 275, and even 460, as a strong curved ray or vivid stream, actually emanating from the material of the nucleus, and gradually losing itself in the envelope.

July 2. The sector was more fully developed; in the comet eyepiece it was hardly discernible from the irradiation of the nucleus; but 110 brought it out beautifully, and it was visible even with 460. It extended, as in fig. 7, through about 125° : the upper inverted edge, which was the brightest part, and barely distinguishable from the nucleus at its origin, standing at an angle of about 190° ; the other edge, shorter, less defined, and apparently a little curved, at about 315° ; a portion of the included area preceding the nucleus was fainter than the rest. The extent of the upper cusp towards the Sun might be $\frac{1}{4}$ th of the distance from the nucleus to the indentation in the envelope No. 4.

July 3. The sector has a greater angular extent than last night, its edges standing at about 170° and 330° . It is very conspicuous in strong twilight, and has a radiated appearance, which had been suspected, but not verified, last night: the edge directed towards the Sun has lost its vivid light, and the brightest portion, which but little exceeds the rest, is a ray standing at about 225° , as in fig. 8. The edges sometimes appear a little concave.

July 4. The fan radiates like an electric brush, strongly reminding me of a similar appearance in the last return of the Comet of Halley. It must have gained considerably in breadth, as it is now well seen in the comet eyepiece. I estimate its extent at more than twice that of July 2. It is very well shown in the micrometer eyepiece, power about 55, with which some measures are attempted. The radius towards the Sun, so bright on July 2, has now become very feeble, and has also advanced in angular position, as in fig. 3; thence the area brightens to a distinct beam, with a thicker and denser extremity; next to this is a space of feeble light, running up far towards the nucleus; and, further on, the circular limb seems to be indented, so as to make the form of the north cusp sharp and long: an appearance increased by the backward curvature of the hinder boundary of the sector. But, excepting the beam with its broader end, which was sufficiently evident, these details were delicate and difficult. The measures of position, such as they were, gave for the south edge 207° (extremely uncertain), the luminous beam 251° , the north edge about 340° . The length of the beam, from its time of passage, appeared to be about $1\frac{1}{2}$ minute of arc.

July 5. The comet eye-piece showed the south edge of the fan more opened backwards, so that its position was more symmetrical; the luminous beam was broader, but less distinct.

July 8. The sector has nearly lost its circular boundary, and it fades down into the coma; but it is still visible, of a dull yellow hue, with 460: a mean of three bad measures of position gave for the south edge, 227° ; for the luminous beam, 271° .

July 10. The sector seems to stand as obliquely as in the last observation; its circular boundary has disappeared, and the stronger ray is very obscure.

July 15. Hazy; sector ill-defined, visible with 460, but contracted in angle, and of a brownish yellow hue.

July 16. Much clearer; the increasing density of the adjacent coma barely leaves a separate existence to the sector, which, however, in the present sky, has recovered its angular extent.

IV. *The Coma.*—This great mist faded away so imperceptibly that no attempt could be made to sketch its boundary; but I regret that I did not endeavour to form some idea of its extent at its first appearance.

On July 4 the whole diameter of the head was very roughly estimated at $20'$; July 10, $18'$; July 15, $13'$. My general impression, towards the close of the observations, was that it had increased in density and brightness as it diminished in extent: this seemed evidently the case on July 16, as, even with so high a power as 460, it was very conspicuous around and beyond the sector. Its most remarkable feature has been its change of colour. On June 30 the whole comet had a strong golden hue. July 10. I have entered it as distinctly white to the naked eye, and in the comet eyepiece tinged with blueish green or greenish blue. This hue was subsequently confirmed with suitable powers on the 15th, the nucleus appearing to have a greenish yellow cast. Considerable allowance must, of course, be made for the removal of the object from the ruddy vapour of the horizon, but still I think the fact of the change is at least highly probable.

V. *The Tail.*—This magnificent appendage was chiefly remarkable for its near approach to us, and consequent apparent length, being far inferior in density and definition to that of "the Donati."

On June 30 I traced it beyond the zenith, giving an extent of at least 90° . It widened out from the nucleus for some degrees, probably to a breadth of 3° or 4° , but was very undefined, and equally so on either side. The east edge appeared to strike off from the coma for a few degrees at a greater angle of divergency, but could not be traced by me as a separate branch; nor did I perceive, probably owing to the intervention of trees, the very interesting ray on that side, which, according to a communication and sketch with which I have been obligingly favoured by George Williams, Esq., of Liverpool, extended from the neighbourhood of the Comet's head as far as, and across, the stars of *Cassiopea*: the brightest part of

this beam, it is stated by the observer, was at some distance from the Comet, and it appeared to recede from it until it was altogether lost.* The main stream was considerably convex towards the west, pointing at its origin to the left of *Polaris*, and subsequently bending back so as to involve that star, which was in its centre about 11^h ; but thence it appeared to the eye of another person, as well as my own, to take a fresh course, directed straight from the nucleus towards β and γ *Lyræ*, its extremity being lost in the space marked out by α *Lyræ*, β and γ *Draconis*, and δ *Cygni*. Its general aspect is represented in fig. 6. By 13^h its edge had reached *Polaris*, but moonlight then began to enfeeble it. About $11^h 45^m$ my wife called my attention to a faint ray of perfectly similar character, stretching under the square of *Ursa Major*, about 3° or $3\frac{1}{2}^\circ$ broad, having ψ *Ursæ Majoris* in its lower edge, and *Cor Caroli* about 1° above its upper, and traceable about half way from the latter star to *Arcturus*. It pointed to the Comet, but in the twilight no connexion could be made out. About 20^m afterwards it had risen higher, so as to stand midway between ψ and γ *Ursæ Majoris*; its further part had now become much more distinct than before, perhaps more so than any other portion of the ray, and its termination was plainly visible near ϵ *Böötis*; some time afterwards I could not see it. From this circumstance, and the character of its motion, opposite to that of the mass of the tail, I concluded it could be only a cirrus cloud brought up by the north-west wind, though the peculiarity of its direction caused me, fortunately, to record it; and from this impression, and my having missed the corresponding beam in *Cassiopea* (which, according to Mr. Williams, was somewhat the brighter of the two), I imagined for some time that the perspective appearance of the tail on this night did not accord with its immediate proximity, as calculated by Mr. Hind; but as the western ray was plainly seen by Mr. Williams at Liverpool about $12^h 30^m$, passing midway between α and β *Ursæ Majoris*, and reaching down towards the head of the Comet, I think there can be little doubt that it was really a part of the tail, whose rapid motion of closing up towards the axis indicated that it was then in the act of leaving the immediate vicinity of the Earth; and thus this most interesting appulse, if not actual conjunction, appears to have been verified by positive observation. Mr. Williams also had supposed that his two rays might be only streaks of cloud, and had been induced, like myself, to record them from the peculiarity of their direction: happily the intervening distance between the observers was such as to remove any suspicion of the kind. That gentleman's sketch, I ought also to observe, gives so great a breadth and so scattered a character to the central portion of the train, that it becomes naturally connected

* A copy of the sketch accompanied Mr. Webb's paper. — Ed.

with these widely divergent lateral appendages. Under these circumstances it is not surprising that I should have failed in detecting any traces of a hollow structure, though I looked for them carefully. No anomalous ray could be perceived towards the Sun.

July 2. The tail was now slightly concave, instead of convex, towards the west; it could be traced nearly to *Wega*, or about 80° ; neither of its edges was at all defined. In the comet eye-piece its central region at some distance behind the nucleus appeared slightly fainter than its sides. Its general direction to-night coincided nearly with the right (inverted) side of the innermost envelope in fig. 2.

July 4. Tail nearly straight; possibly a slight double curvature, first to the left (or west), then to the right, but it is quite uncertain. It appears more dense for some distance from the head; both sides are equally ill-defined. The nucleus seems to stand at the vertex of a wide but very ill-marked parabola, part of which is formed by the north edge of the fan, and within which was rather less light than at the sides; the coma, in passing off along each side of this space to form the train, was somewhat brighter on the north; but all this was so indistinct as to require close attention, and nothing like two separate streams could anywhere be seen, nor was there any anomalous ray.

July 5. The tail appears, as last night, a little denser at its origin on the north, or orbitally following side; and rapid cross-sweeping with the comet eye-piece detects a slightly darker interior, commencing near the nucleus, but not traceable for any considerable distance.

July 6. The tail is again slightly turned to the left.

July 8. Tail about 14° or 15° , and streaky to the naked eye. I am not sure whether I have not noticed this before. In the comet eyepiece it had a narrow ray in the centre, or rather, a little way behind the coma, I saw nothing but a faint ray, about $5'$ broad by estimation, and several degrees in length. On the north side the coma passed off into a faint branch of about the same width, and perhaps $30'$ long., fading gradually away; on the other side I could find nothing corresponding. Hence I concluded that this branch and the longer ray were the two sides of a hollow tail, till further examination, and especially with the finder, convinced me to the contrary. In this little instrument the whole tail rose in one stream from the whole coma; and the ray, having been previously perceived, could be seen to form its axis for some distance. Fig. 4 is the appearance in the comet eyepiece; fig. 9 that in the finder.

July 10. I studied the tail carefully, and think that I misconceived its structure the night before last: the two branches, as in fig. 4, are, after all, a double train with a darker interior. I was misled by its coming off from the coma with a sudden

turn downwards (inverted): the lower is the fainter and shorter of the two branches, reaching about 2° ; the other is much the longer; it is broader than on the 8th, but, notwithstanding a very transparent sky, less defined. There is no other branch on the opposite side, and it is obviously the edge, and not the centre of the tail. Fig. 4 still suits it well: a very careful scrutiny with the finder detects no central ray. The bend downwards is very visible with this little glass, and perceptible to the naked eye.

July 15. Powers of 55 and 110 showed no dark interior, but it could be distinctly made out in the comet eyepiece, though not near the nucleus, and could be traced for about 1° . The streams on each side were nearly alike—possibly the orbitally preceding may be the more dense; the head still seemed, as it were, set on a little awry.

July 16 and 23. Hollow structure difficult to be perceived.

A few general remarks may be permitted at the close of these observations.

It may fairly be inferred, from the absence of any phasis, that the visible nucleus either contained no concentration of opaque matter, or shone by intrinsic light. Its axial rotation seems improbable, if, as may reasonably be supposed, the more luminous rays always issued from the same portions of it. On the other hand, some amount of libration might be deduced from the varying angles of position of certain portions of the sector, if only the measures could be thought worthy of sufficient confidence.

The similarity of the brilliant jet of June 30 to the streams which issued from the nucleus of Halley's Comet in 1835 is as obvious as that of the subsequently formed sector to some of the phenomena of the Comet of Donati; and the unsymmetrical arrangement, so evident in 1858, was again conspicuous. The sector was of later date than the envelopes, and much posterior to the perihelion passage. The descent of the envelopes upon the nucleus in the Comet's retreat from the sun corresponded with the similar process described by Herschel and Schröter in 1811; and this probably may have been the cause of the increasing apparent density of the whole coma.

There were no indications of rotation in the tail. Any general curvature which it may have possessed was masked by its position; but minor deviations in direction were sufficiently evident.

The obliquity of the sector and envelopes with respect to the axis of the tail might be thought to indicate that a stronger repulsion or a less resisted emissive force acted in one direction from the nucleus than in the opposite. The nebulous veils, without any difference as to extent, showed invariably greater distinctness and definedness on one side of the head than on the other. Unfortunately the position of the Comet's orbit

Comet I.-II. 1862.

was such during these observations that it was not possible to obtain a fair view of the arrangement in the plane of its motion, or to form a satisfactory idea how far these phenomena may have arisen from any external resistance.

Hardwick Parsonage, December 24th, 1861.

Comet I., 1862.

The Comet appears to have been first observed by Mr. Schmidt, at Athens, about half-past ten on the evening of July 2, near the stars β , ϵ , σ , *Cassiopeiæ*. It was seen about midnight by M. Tempel, at Marseilles, and by Mr. Bond, at Harvard College, on the evening of July 3d (see *Ast. Nach.* Nos. 1369, 1370, and 1374). Elements have been computed by Dr. Seeling, Mr. Hall, Mr. H. P. Tuttle, and Dr. Weiss; those of Dr. Weiss, computed from the Athens and Marseilles Observations of July 2, 3, 5, are as follows:—

$$T = \text{June } 22^{\circ}54'30'' \text{ G.M.T.}$$

$$\Omega = 324^{\circ}30'4'' \quad \text{Mean Eq.}$$

$$\Pi = 298^{\circ}35'2'' \quad 1862^{\circ}0.$$

$$i = 8^{\circ}14'2''$$

$$\log q = 9.99242.$$

Motion retrograde.

Comet II., 1862.

The Comet was discovered by MM. Pacinotho and Tous-saint, at Florence, on the 22d July (*Ast. Nach.* No. 1374). The elements, as calculated by Dr. Hornstein, from observations of July 24, 27, and August 1, are as follows:—

$$T = 1862, \text{ Aug. } 23^{\circ}7'1395, \text{ Berlin M.T.}$$

$$\Omega = 137^{\circ}4'32''8 \quad \text{Mean Eq.}$$

$$\Pi = 344^{\circ}16'13''6 \quad 1862^{\circ}0.$$

$$i = 66^{\circ}3'4''1$$

$$\log q = 9.9847732.$$

Motion retrograde.